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Status of witch flounder in NAFO Divisions 4RS

by

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ABSTRACT

The provisional landings of witch flounder in NAFO Divisions 4R and 4S totalled 453 t in 1991 and 376 t in 1992. A summertime seine fishery contributed most of the 374 t originating from 4R in 1991 (332 t in 1992). The landings of witch in 4RS during 1991 and 1992 are among the lowest within the available data series beginning in 1960. Research surveys of 4RS, conducted during summer and winter since 1983, indicate a reduction in abundance in 4R since 1983. Summer surveys of 4S indicate a similar decline since 1986. Abundance indices based on winter surveys in 4S vary from year to year, largely due to limited strata coverage. Although 4T is not included as part of any witch management unit, research surveys in 4T caught significant numbers of witch near the 4S border and significant commercial catches of witch have been reported from 4T since 1984. The current stock unit definition may not be appropriate.

RÉSUMÉ

Selon les données provisoires, les débarquements de la plie grise dans les divisions 4R et 4S de l'OPANO ont atteint 453 t en 1991 et 376 t en 1992. La pêche estivale par les seineurs a contribué la majeure partie des 374 t provenant de 4R en 1991 et des 332 t en 1992. Les débarquements de plie grise dans les divisions 4RS en 1991 et 1992 sont près des plus bas niveaux parmi les données disponibles depuis 1960. Les relevés scientifiques, effectués dans 4RS durant l'été et l'hiver depuis 1983, indiquent une réduction dans l'abondance de plie grise de 4R depuis 1983. Les relevés estivaux de 4S indiquent une réduction semblable depuis 1986. Les indices d'abondance qui sont basés sur les relevés d'hiver varient d'une année à l'autre selon le degré de couverture des strates. La plie grise de 4T n'est pas reconnue comme faisant partie de l'unité de stock 4RS. Cependant, des captures importantes sont enregistrées dans les strates qui bordent la zone 4S lors des relevés scientifiques et une pêche relativement importante de plie grise est rapportée dans la Division 4T. Ceci laisse croire que la définition de l'unité de stock est à reconsiderer.

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INTRODUCTION

Witch flounder (*Glyptocephalus cynoglossus*) occur in the western North Atlantic from southern Labrador in the north, as far south as the Gulf of Maine and North Carolina (Scott and Scott 1988). Witch flounder are frequently associated with mud and mud-sand bottoms, at depths of 180-366 m and temperatures ranging 2-6°C (Powles and Kohler 1970, Bowering 1976).

The witch flounder commercial fishery first developed along with the introduction of otter trawling to Newfoundland in the 1940s. The fishery began to exploit Gulf of St. Lawrence stocks in the 1950s when declining catches by Danish seiners in Fortune Bay, Newfoundland (NAFO Division 3Ps) caused the fleet to move to St. George's Bay (4R) (Bowering 1979). A small directed fishery for witch developed in St. Georges Bay during the summertime, while in the winter, witch became a bycatch of cod and redfish-directed fisheries. The witch flounder fishery expanded in the Gulf from St. George's Bay during the 1970s to the Esquiman Channel and the northern shores of Cape Breton Island.

Witch flounder fisheries came under international quota regulation in 1974; at the same time, stock unit areas were defined on the basis of current biological information. In 1977, a precautionary quota of 3,500 t was set for Division 4RS, based on catch statistics. The first analytical assessment of 4RS witch was conducted in 1978 (Bowering 1978). Research data on this stock were analysed yearly up to 1981 (Bowering and Brodie 1980, Bowering 1981), but have not included catch-at-age data since then. The Groundfish Subcommittee of CAFSAC continued to review the status of the stock yearly mostly on the basis of landed catches. In 1991, Tallman and Forest-Gallant combined information on catch statistics and research survey data in their assessment of the status of 4RS witch. In this document, we update the status of witch flounder in 4RS based on catch statistics and summary analysis of survey catch data from 1991 and 1992. The Groundfish Subcommittee of CAFSAC recommended in 1990 that witch and other flatfishes be assessed every three years, unless otherwise recommended by the fishing industry.

Description of the fishery

Landings of witch flounder in 4RS during 1991 and 1992 were near their lowest level since 1960 (Tables 1, 2, 3). Otter trawls contributed most of the annual witch landings until 1980 in 4R. Since 1981, seining gear has increasingly dominated witch landings in 4R (Table 1). Otter trawls continue to contribute the majority of witch landings in 4S where landings totalled 45 t in 1992, well below the long-term average of 312 t (Table 2). Between 1991 and 1992, there was a noticeable reduction in the number of gear types that contributed to witch landings in 4R and 4S (Tables 5 and 6). The winter fishery for witch that was concentrated in the months of January and February during the late 1970s (Lafleur and Lussiaà-Berdou 1982), was no longer present in 1991 and 1992 (Tables 4 and 5). In general, the 4RS witch fishery now concentrates during the mid summer and autumn months (Table 6).

The status of 4RS witch as a discrete stock has been a longstanding issue. Bowering (1978) questionned whether witch fished in 4T off northern Cape Breton should not be considered as part of the 4RS stock. Lafleur and Lussiaà-Berdou (1982) suggested that 4RS witch comprised two stocks based on differences in the size composition, growth rates and mortality between 4R and 4S. Tallman and Gallant (1991) noted significant numbers of witch flounder in research surveys of 4T strata that border 4RS. Figure 1 shows landings of 4R, 4S and 4T witch since 1963. The 4R witch fishery dominated landings through the latter part of the 1960s and most of the 1970s; however, since 1984 the 4T fishery contributes most of the Gulf landings of witch flounder. This may be further evidence that the current stock unit definition is inappropriate.

Bowering (1978) described the 4RS witch stock as composed of numerous old (up to age 26 years), slow-growing fish. Many of these were landed in "jellied" condition, providing a poor market product. In 1979, the TAC on the stock was raised from 3,500 t to 5,000 t in order to remove the slow-growing component of the stock and improve growth rates of younger witch. Between 1976 and 1981, the growth rates of male and female witch increased significantly, the life span decreased from 26 to 16 years, while stock biomass and size at maturity remained stable (reviewed by Bowering and Brodie 1984). Although the management plan succeeded in removing the large aged component of the population, landings of witch in 4RS peaked in 1976 and declined in following years (Table 3), failing to reach the TAC of 5,000 t. In 1982, the TAC was returned to 3,500 t and has not been changed since then.

Research survey data

Seasonal research vessel surveys of groundfish have been conducted in the northern Gulf since 1983 by the Quebec Region of DFO (Figure 2). Summer surveys were conducted from 1984 to 1989 with the *Lady Hammond*, fishing mainly for redfish. In 1990, the *Lady Hammond* was replaced by the *Alfred Needler*, with the purpose of combining concurrent surveys for redfish and shrimp. In addition to changing vessels, the *Alfred Needler* deployed a different trawl and reduced the speed and duration of tows. The Statistics, Sampling and Surveys Subcommittee of CAFSAC reviewed the data from a comparative survey conducted in 1990 and concluded that it was not possible to derive a conversion factor for the two vessels . Comparing data on witch catches from the two vessels, it was noted that the size composition was similar for the two vessels but that the *Alfred Needler* caught approximately half as much witch and American plaice as the *Lady Hammond*.

Mean numbers per tow by stratum and weighted division means are presented in Table 7 for winter surveys of the *Gadus Atlantica*. Several strata were missed in certain years due to ice and weather conditions, particularly in NAFO Division 4S. Similar data are presented in Table 8 for summer surveys. The longterm trend in mean numbers per tow from surveys indicates declining abundance in 4R since 1983. Summer surveys of 4S indicate a similar pattern of declining abundance since 1986 (Table 8), although part of this decline is attributed to the effect of changes in research vessels. The mean abundance of witch in winter surveys of 4S have fluctuated widely from year to year, largely due to variations in strata coverage. Winter surveys since 1991 indicate high concentrations of witch in the Laurentian Channel, including 4T strata (Table 7). Surveys conducted during recent summers indicate average catches in the upper Gulf (4T strata 411-414) that are well above the mean for 4RST (Table 8).

Minimum stock biomass was calculated in 4R, 4S and 4T based on research vessel surveys for years with sufficient coverage. The results from summer surveys (Table 9) indicate declining biomass in all divisions and increasing proportion of the biomass found in 4T. Abundance estimates from winter surveys in 4S varied widely over time and exhibit no clear trend; however, strata coverage was frequently limited during the winter surveys, contributing to the observed variability in catch

Prognosis

Biological information on 4RS witch has not been brought up to date since the early 1980s; however, it appears from both commercial catches and survey data that the abundance of witch in 4RS is in decline. The current TAC of 3,500 t is high in relation to catches since 1981. The current stock unit definition may be inappropriate.

Acknowledgements

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Table 1. Yearly landings of witch flounder in NAFO Division 4R by major gear types. Gear codes: OTB=otter trawls (unspecified), OTB1=otter trawl side, OTB2=otter trawl stern, SNU=seines, GNS=gillnets, LLS=longlines, LH=handlines.

	GEAR								
YEAR	OTB	OTB1	OTB2	SNU	GNS	LLS	LH	OTHER	TOTAL
1960	250	0	0	764	0	0	0	26	1040
1961	129	0	0	1409	0	0	0	14	1552
1962	114	0	0	1433	0	0	0	5	1552
1963	49	0	0	2047	0	0	0	0	2096
1964	304	0	0	1413	0	0	0	0	1717
1965	156	0	0	1464	0	0	0	0	1620
1966	0	184	4	1083	0	0	0	0	1271
1967	1	240	19	786	0	0	0	0	1046
1968	0	286	84	861	0	0	0	0	1231
1969	0	639	175	2427	0	1	0	0	3242
1970	0	576	341	2298	0	0	0	0	3215
1971	17	251	139	1604	2	0	0	0	2013
1972	23	243	207	68	2	0	0	7	550
1973	47	86	35	559	7	9	0	8	751
1974	0	218	720	1259	3	0	0	8	2208
1975	0	288	227	1134	6	4	0	5	1664
1976	0	839	2583	101	9	0	0	91	3623
1977	0	496	858	605	4	0	0	5	1968
1978	0	346	2247	787	2	3	0	44	3429
1979	0	485	1564	1007	20	4	0	7	3087
1980	1	208	1149	797	31	0	0	0	2186
1981	15	44	74	729	15	0	0	0	877
1982	22	52	101	733	17	0	0	0	925
1983	40	6	48	577	10	9	0	0	690
1984	20	8	36	0	15	0	0	0	79
1985	21	6	87	539	0	6	0	0	659
1986	30	4	36	480	3	1	0	0	554
1987	46	0	45	757	0	0	0	0	848
1988	43	2	36	946	31	1	0	2	1061
1989	29	0	54	951	46	0	0	0	1080
1990*	0	8	65	397	20	14	0	4	508
1991*	0	0	28	314	27	2	0	3	374
1992*	0	0	31	285	11	2	0	3	332
MEAN	41	167	333	928	9	2	0	7	1486

* Provisional data

Table 2. Yearly landings of witch flounder in NAFO Division 4S by major gear types. Gear codes as in Table 1.

YEAR	GEAR								TOTAL
	OTB	OTB1	OTB2	SNU	GN	LL	LHP	OTHER	
1960	44	0	0	0	0	3	0	0	47
1961	58	0	0	0	0	16	1	0	75
1962	37	0	0	1	0	22	0	0	60
1963	236	0	0	5	0	21	4	0	266
1964	182	0	0	0	0	86	0	195	463
1965	333	0	0	0	0	36	0	0	369
1966	0	242	5	0	0	3	0	3	253
1967	0	179	1	0	3	4	1	0	188
1968	0	301	3	0	10	13	0	0	327
1969	3	219	96	0	0	0	0	0	318
1970	11	274	102	0	0	0	0	0	387
1971	0	381	7	0	9	40	0	0	437
1972	7	378	10	0	0	7	0	0	402
1973	19	116	1	0	0	0	0	0	136
1974	0	148	154	0	10	0	0	0	312
1975	61	116	90	0	0	0	0	14	281
1976	98	334	1262	0	0	0	0	24	1718
1977	96	171	359	1	0	0	0	1	628
1978	3	238	510	0	45	0	0	70	866
1979	61	340	219	0	74	7	0	0	701
1980	41	235	465	0	19	27	0	0	787
1981	72	92	158	2	0	18	0	0	342
1982	50	32	19	0	0	2	0	0	103
1983	30	39	4	0	0	1	0	0	74
1984	19	68	8	0	3	11	0	0	109
1985	5	5	6	0	1	0	0	21	38
1986	7	3	2	152	0	0	0	9	173
1987	12	6	31	0	0	2	0	5	56
1988	9	37	13	0	0	0	0	13	72
1989	9	30	66	0	0	0	0	0	105
1990*	0	14	49	1	1	0	0	17	82
1991*	0	1	58	1	9	0	0	10	79
1992*	0	2	32	0	0	0	0	11	45
MEAN	46	121	113	5	6	10	0	12	312

* Provisional data

Table 3. Yearly landings of witch flounder in NAFO Division 4RS by major gear types. Gear codes as in Table 1.

	GEAR								
YEAR	OTB	OTB1	OTB2	SNU	GN	LL	LHP	OTHER	TOTAL
1960	294	0	0	764	0	3	0	26	1087
1961	187	0	0	1409	0	16	1	14	1627
1962	151	0	0	1434	0	22	0	5	1612
1963	355	0	0	2052	0	21	4	0	2432
1964	486	0	0	1413	0	86	0	195	2180
1965	489	0	0	1464	0	36	0	0	1989
1966	0	426	9	1083	0	3	0	3	1524
1967	1	419	20	786	3	4	1	0	1234
1968	0	587	87	861	10	13	0	0	1558
1969	3	858	271	2427	0	1	0	0	3560
1970	11	850	443	2298	0	0	0	0	3602
1971	17	632	146	1604	11	40	0	0	2450
1972	30	621	217	68	8	7	0	0	951
1973	66	202	36	559	7	9	0	0	879
1974	0	366	874	1259	13	0	0	8	2520
1975	61	404	317	1134	6	4	0	19	1945
1976	98	1173	3845	101	9	0	0	115	5341
1977	96	667	1217	606	4	0	0	6	2596
1978	3	584	2757	787	47	3	0	114	4295
1979	61	825	1783	1007	94	11	0	7	3788
1980	42	443	1614	797	50	27	0	0	2973
1981	87	136	232	7	15	18	0	724	1219
1982	72	84	120	0	17	2	0	733	1028
1983	70	45	52	0	10	10	0	577	764
1984	39	76	44	0	18	11	0	0	188
1985	26	11	93	539	1	6	0	21	697
1986	37	7	38	632	3	1	0	9	727
1987	58	6	76	757	2	0	0	5	904
1988	52	39	49	946	31	1	0	15	1133
1989	38	30	120	951	46	0	0	0	1185
1990'	0	22	114	398	21	14	0	21	590
1991'	0	1	87	316	36	2	0	13	455
1992'	0	2	63	285	11	2	0	14	377
MEAN	89	288	446	871	14	11	0	80	1800

' Provisional data

Table 4. Preliminary landings (t) of 4R witch in 1991 and 1992 by gear and month. Values of 0 indicate landings of less than 50 kg; "-" indicates no landings. Gear types: OTB2= otter trawl-stern, OTM2= midwater trawl-stern, TXS= shrimp trawl, SDN= pair seine, SSC= scottish seine, GNS= gillnet, LLS= set lines, LHP= handlines, FPN= uncovered pound nets.

MONTHS 1991													
GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OTB2	2	4	4	2	2	2	2	0	5	3	0	3	28
OTM2	-	0	-	-	0	-	0	-	-	-	-	0	0
TXS	-	-	-	-	2	0	0	0	-	-	-	-	3
SDN	-	-	-	0	50	45	71	52	27	42	27	0	313
SSC	-	-	-	-	-	-	1	-	-	-	-	-	1
GNS	-	-	-	-	0	5	15	6	0	0	-	-	27
LLS	-	-	-	-	-	1	1	0	0	-	-	-	2
LHP	-	-	-	-	-	-	0	-	-	-	-	-	0
TOTAL	2	4	4	2	54	53	90	58	32	45	27	3	374

MONTHS 1992													
GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OTB2	4	1	-	3	19	1	-	-	-	-	1	1	31
TXS	-	-	-	-	0	1	0	-	-	-	-	-	2
SDN	-	-	-	0	23	60	73	33	40	28	24	5	285
GNS	-	-	-	-	-	3	5	1	1	2	0	-	11
LLS	-	-	-	-	-	-	-	-	-	-	2	-	2
FPN	-	-	-	-	-	-	1	0	-	-	-	-	1
TOTAL	4	1	0	3	42	65	79	34	41	30	27	6	332

Table 5. Preliminary landings (t) of 4S witch in 1991 and 1992 by gear and month. Values of 0 indicate landings of less than 50 kg; "-" indicates no landings. Gear types:OTB1= otter trawl-side, OTB2= otter trawl-stern, OTM2= midwater trawl-stern, TXS= shrimp trawl, SDN= pair seine, GNS= gillnet.

MONTHS 1991

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OTB1	-	-	-	-	-	-	-	1	-	-	-	-	1
OTB2	-	-	-	-	5	20	16	3	11	2	-	1	58
TXS	-	-	-	0	3	2	1	0	0	2	0	0	10
SDN	-	-	-	-	-	-	-	-	-	0	1	-	1
GNS	-	-	-	-	1	3	5	0	-	-	-	-	9
TOTAL	0	0	0	0	9	25	22	5	12	4	1	1	79

MONTHS 1992

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OTB1	-	-	-	-	-	-	0	1	1	0	-	-	2
OTB2	0	-	-	-	0	3	6	14	8	1	0	-	32
OTM2	-	-	-	-	-	-	-	-	-	-	0	-	0
TXS	-	-	-	0	5	3	2	0	0	0	-	-	11
TOTAL	0	0	0	0	5	7	8	15	9	1	0	0	45

Table 6. Preliminary landings (t) of 4RS witch in 1991 and 1992 by gear and month. Values of 0 indicate landings of less than 50 kg; "-" indicates no landings. Gear types:OTB1= otter trawl-side, OTB2= otter trawl-stern, OTM2= midwater trawl-stern, TXS= shrimp trawl, SDN= pair seine, SSC= scottish seine, GNS= gillnet, LLS= set lines, LHP= handlines, FPN= uncovered pound nets.

	MONTHS 1991												
GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OTB1	-	-	-	-	-	-	-	1	-	-	-	-	1
OTB2	2	4	4	2	7	22	18	3	16	5	0	4	87
OTM2	-	0	-	-	0	-	0	-	-	-	-	0	0
TXS	-	-	-	0	7	3	1	0	0	2	0	0	13
SDN	-	-	-	0	50	45	71	52	27	42	28	0	315
SSC	-	-	-	-	-	-	1	-	-	-	-	-	1
GNS	-	-	-	-	1	8	20	7	0	0	-	-	36
LLS	-	-	-	-	-	1	1	0	0	-	-	-	2
LHP	-	-	-	-	-	-	0	-	-	-	-	-	0
TOTAL	2	4	4	2	65	79	112	63	43	49	28	4	455

	MONTHS 1992												
GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OTB1	-	-	-	-	-	-	0	1	1	0	-	-	2
OTB2	4	1	-	3	19	4	6	14	8	1	1	1	62
OTM2	-	-	-	-	-	-	-	-	-	-	0	-	0
TXS	-	-	-	0	5	5	2	1	0	0	-	-	13
SDN	-	-	-	0	23	60	73	33	40	28	24	5	285
GNS	-	-	-	-	-	3	5	1	1	2	0	-	11
LLS	-	-	-	-	-	-	-	-	-	-	2	-	2
FPN	-	-	-	-	-	-	1	0	-	-	-	-	1
TOTAL	4	1	0	4	47	71	86	50	50	30	27	6	376

Table 7. Mean number per tow by stratum estimated from winter surveys of the *Gadus Atlantica* with division mean numbers per tow weighted by stratum size. Strata 401-408 are in NAFO Division 4T. "." indicates no fishing.

STRATUM	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
401	4.00	1.67	.	1.00	.	0.00	.	.	0.67	.	0.67
402	2.00	0.00	.	.	.	.	.	.	.	.	.
404	2.00	2.33	.	4.33	.	1.75	.	.	0.75	.	0.67
405	1.00	0.33	.	.	0.25	1.50	.	.	.	.	.
407	30.50	10.50	.	21.33	.	48.29	.	64.50	49.00	.	62.20
408	13.00	14.14	.	.	8.00	33.75	0.67	.	.	.	6.50
801	13.67	86.50	153.67	40.33	56.50	37.00	.	.	33.50	6.00	10.75
802	34.57	9.40	96.00	53.00	195.33	146.33	136.33	35.50	76.83	118.31	51.28
803	21.45	31.59	113.40	64.26	53.94	49.44	57.50	52.79	26.00	.	82.50
804	12.00	19.00	25.00	.	11.60	.	.	.	.	.	8.00
805	9.33	.	.	.	.	.	.	.	.	.	.
806	0.50	.	.	.	.	.	.	.	.	.	.
807	4.00	1.83	5.17	1.00	5.02	0.67	0.00	1.33	.	.	1.25
808	30.13	22.00	43.00	91.10	37.63	5.50	10.17	9.75	.	22.75	8.40
809	38.00	67.00	34.13	109.57	62.50	14.00	19.56	6.00	8.25	4.50	5.20
810	7.00	47.00	115.00	15.71	10.25	5.00	2.67	1.67	1.57	1.60	1.83
811	2.57	6.43	4.43	7.25	6.50	1.00	2.50	0.43	0.50	0.75	0.43
812	13.50	10.56	4.71	10.40	2.60	3.46	4.65	1.13	4.00	0.80	0.75
813	10.04	18.40	9.30	36.90	1.50	2.88	5.17	1.50	0.00	0.75	1.25
814	1.33	5.33	5.20	0.00	3.00	0.67	.	.	0.00	0.00	1.00
815	4.00	11.13	18.90	3.50	7.56	6.91	3.17	4.83	.	0.00	.
816	5.10	18.50	11.25	.	.	4.77	6.00	.	.	0.00	.
817	3.33	.	.	.	.	.	.	.	.	0.00	.
818	2.67	.	.	.	.	.	.	.	.	0.00	.
819	0.00	1.75	4.43	4.20	3.00	2.67	0.40	1.00	.	0.00	0.75
820	0.86	3.80	1.60	4.13	2.80	0.00	1.33	0.17	0.00	.	0.00
821	0.43	0.40	0.60	0.11	0.33	0.00	0.00	0.83	0.14	.	0.00
822	1.90	0.38	4.50	2.56	0.88	0.25	0.13	0.00	0.00	.	0.00
823	17.00	26.25	20.33	5.67	.	.	0.50	0.33	.	.	0.00
824	1.00	1.33	0.00	0.50	.	0.00	.	.	.	.	.
825	1.50	.	.	.	.	.	.	.	.	.	.
826	0.00	.	.	.	.	.	.	.	.	.	.
827	0.00	0.40	0.00	0.00	.	0.20	.	.	.	.	.
828	0.00	.	.	.	.	.	.	.	.	.	.
829	0.00	0.50	.	.	0.50	0.14	0.00	.	.	.	.
830	0.00	0.25	0.20	0.00	0.00	0.00	0.00	0.00	.	.	.
832	0.00	.	.	.	.	.	.	.	.	.	.
833	0.00	0.33	0.67	.	.	0.00	.	.	.	.	.
835	0.00	.	.	.	.	0.80	0.00	0.00	.	.	.
836	0.00	.	.	.	.	0.00	.	.	.	.	.
MEANS											
4R	11.84	19.17	26.47	25.32	24.03	14.79	14.49	3.94	9.22	9.11	5.22
4S	5.87	13.73	33.60	27.36	20.56	11.20	15.18	17.78	19.15	9.51	33.07
4T	12.94	7.55	.	14.65	5.28	26.46	0.67	64.5	31.42	.	25.58
4RST	8.10	14.58	30.94	25.59	20.61	14.13	14.18	14.55	14.62	9.20	19.89

Table 8. Mean numbers per tow by stratum of witch flounder from summer surveys of the *Lady Hammond* (1984-1989) and the RV *Alfred Needler* (since 1990). Strata 401-408 are in NAFO Division 4T. "." indicates no fishing effort.

STRATUM	1984	1985	1986	1987	1988	1989	1990	1991	1992
401	0.00	2.20	.	.	5.27	2.38	3.26	0.50	0.50
402	.	8.70	3.01	7.00	5.44	5.32	17.55	11.09	0.86
403	.	51.72	56.76	3.71	39.53	6.00	2.67	2.89	0.56
404	2.54	3.25	3.85	8.15	2.67	1.71	0.30	0.00	0.33
405	2.29	2.25	1.71	6.00	3.45	1.04	0.44	0.00	0.00
406	.	5.00	5.82	2.69	4.06	0.80	2.02	0.62	0.30
407	3.15	3.16	4.44	6.05	11.10	7.91	2.31	0.89	0.69
408	2.22	3.40	11.38	4.80	3.73	1.97	1.42	2.44	0.53
409	.	.	.	42.65	28.99	13.42	19.48	14.44	14.00
410	.	.	19.55	.	9.86	6.33	1.33	16.00	0.53
411	.	.	.	41.29	15.78	.	15.97	27.56	34.93
412	.	.	.	64.50	18.35	.	18.74	36.24	41.43
413	.	.	.	48.20	21.75	.	19.00	13.44	34.20
414	.	.	.	4.00	22.22	.	15.41	11.82	8.67
801	38.38	7.08	12.00	2.00	5.59	4.54	7.48	6.89	1.19
802	8.54	6.06	13.33	8.24	14.18	6.65	6.59	1.87	0.00
803	7.50	5.27	11.41	5.18	7.31	9.19	1.70	8.61	0.00
804	8.44	3.18	9.57	6.45	6.35	2.68	0.18	1.07	0.63
805	9.29	27.31	14.80	8.70	6.97	1.73	3.12	7.28	4.40
806	11.25	0.98	9.84	5.62	6.50	0.33	1.22	0.67	0.30
807	1.14	3.26	10.09	3.05	4.18	1.24	1.19	1.07	0.08
808	3.48	1.56	3.65	4.08	5.87	2.91	1.92	0.38	0.15
809	2.76	7.27	.	7.00	4.01	2.00	3.38	1.65	0.38
810	4.31	17.25	5.04	11.11	6.63	3.00	1.67	0.44	0.80
811	1.50	10.56	8.49	5.15	1.73	1.67	3.26	0.85	2.06
812	0.45	1.96	4.41	3.94	2.94	1.77	3.98	5.97	1.79
813	.	6.45	24.66	7.39	3.14	3.16	0.48	1.07	0.00
814	.	1.02	.	5.21	6.33	2.33	1.00	2.22	0.67
815	.	4.82	3.82	3.47	2.07	1.59	0.59	0.42	0.34
816	15.13	7.82	15.67	5.78	7.45	4.29	8.70	5.22	1.54
817	5.84	14.39	17.19	16.84	9.74	6.26	3.56	13.27	12.57
818	14.54	2.81	24.96	19.46	5.53	6.42	1.96	1.42	0.86
819	.	3.39	6.80	4.66	4.22	0.67	0.30	1.49	1.01
820	0.00	2.48	4.95	10.06	19.04	0.33	0.89	2.15	6.11
821	1.00	0.69	7.04	1.00	1.32	4.00	1.05	0.80	0.30
822	5.70	0.74	3.27	4.83	5.69	3.37	2.81	0.67	0.33
823	15.69	7.58	9.84	54.00	30.71	26.00	0.00	1.16	0.33
824	6.86	2.29	4.00	46.11	5.81	2.35	1.39	.	0.00
825	.	50.65	4.68	.	0.00	.	0.00	.	.
827	.	8.55	1.76	3.41	4.51	.	2.43	.	.
828	.	2.00	1.06	0.50	8.32	10.93	3.26	1.82	0.00
829	.	2.23	12.00	0.00	6.21	4.23	0.89	.	0.53
830	1.59	0.67	5.16	0.25	3.50	1.00	19.00	0.29	1.48
831	.	1.96	0.45	10.00	14.56	8.11	0.00	.	1.33
832	.	40.39	506.19	30.40	39.78	45.91	.	12.82	0.00
833	.	.	.	0.47	1.06	0.32	.	.	0.00
MEANS									
4R	5.75	4.18	9.88	7.41	5.66	2.93	2.86	2.68	1.02
4S	8.24	12.45	42.41	8.19	8.16	7.47	3.65	4.00	1.36
4T	2.39	8.45	12.13	17.18	11.78	4.30	6.65	9.13	8.48
4RST	6.83	10.14	31.35	9.65	8.70	5.92	4.10	4.74	2.54

Table 9. Total biomass (t) in stata corresponding to NAFO Divisions, based on sampling by the *Lady Hammond* (1984-1989) and the *Alfred Needler* (since 1990). "-" indicates inadequate coverage for biomass estimate.

YEAR	4R	4S	4T
1984	943	-	-
1985	1629	3860	-
1986	1459	23779	-
1987	1212	3872	2743
1988	1116	3652	1787
1989	420	2287	-
1990	[illegible]	2176	1036
1991	334	1051	1685
1992	225	351	940

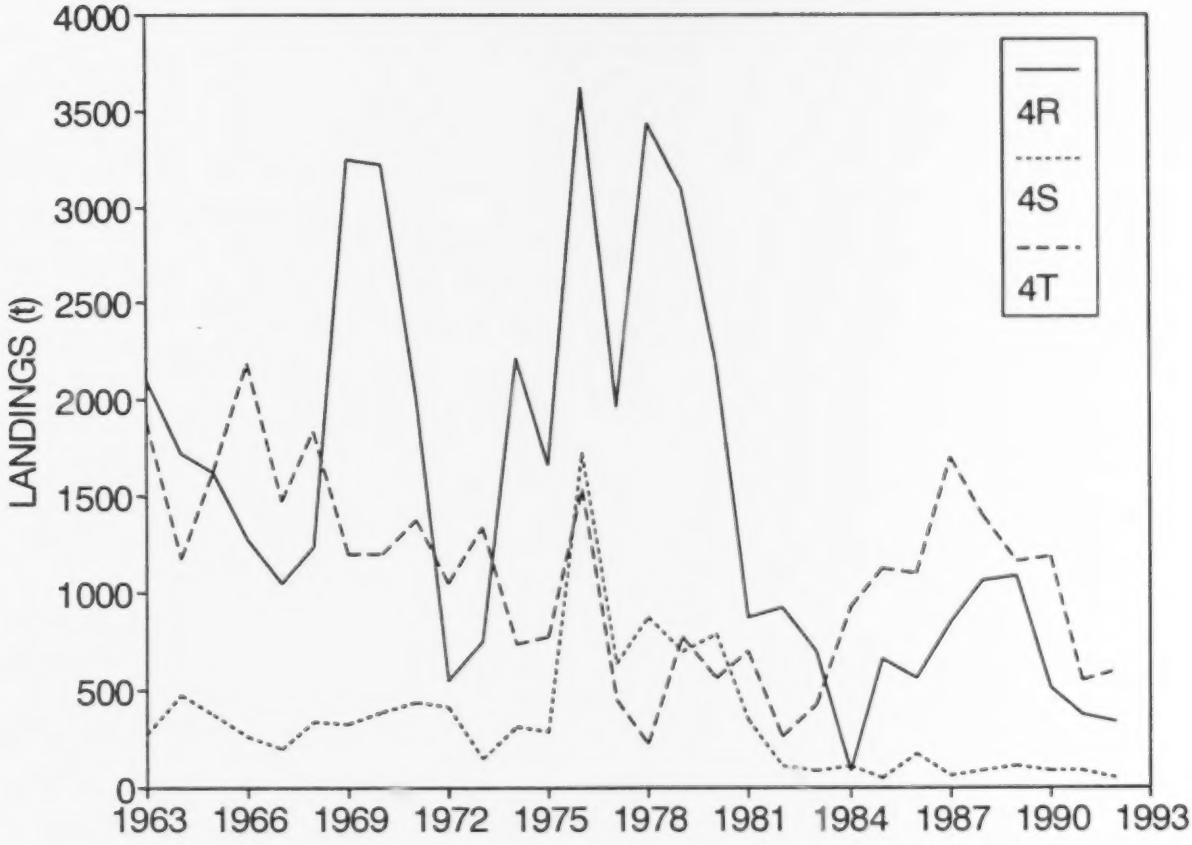

Figure 1. Annual landings of witch flounder by NAFO division.

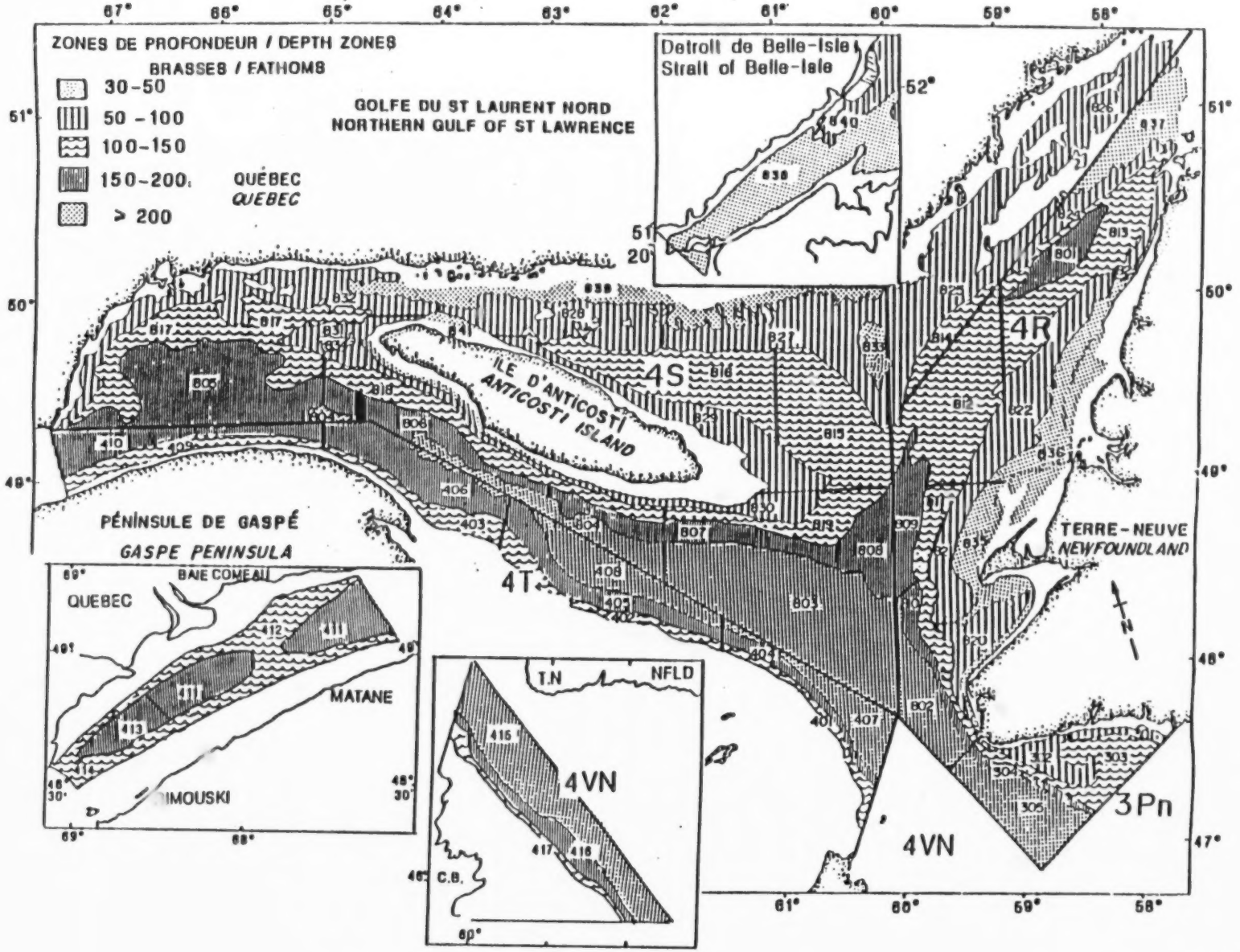

Figure 2. Strata boundaries in research surveys of 4RST, conducted by the Québec Region of DFO.